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ECOLOGY PROJECT
INTERNATIONAL

SUMMARY REPORT

October 2013

Environmental literacy assessment

During 2013, Ecology Project International (EPI) developed and implemented pre- and post-course assessment tools based on the National American Association of Environmental Education (NAAEE) framework for the evaluation of environmental literacy. We surveyed 281 high school participants from public and private schools in our Costa Rica program. The results showed that EPI Costa Rica has a positive overall effect in improving environmental literacy in high school students, with a significantly high impact in reinforcing Competencies in inquiry-based science and Behaviors that are pro-environment

October 2013

Environmental literacy assessment

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Summary report

ENVIRONMENTAL LITERACY ASSESSMENT

THE PROGRAM

Ecology Project International (EPI) develops and implements inquiry-based, hands-on, outdoor education experiences for high school students with the objective of empowering them to take an active lifelong role in conservation. EPI's programs immerse participants in experientially-rich curricular environments at unique locations around the globe; our students work side-by-side with researchers monitoring endangered species or habitats as a means to inspire meaningful conservation action.

Ecology Project International (EPI) is an NGO registered in USA as a 501(c)(3) and with operations in six countries throughout the United States and Latin America.

ENVIRONMENTALLY LITERATE YOUNG PEOPLE ARE EMPOWERED YOUNG PEOPLE

In order for individuals to practice conservation, they need to understand and value nature, develop the necessary and relevant skills to take appropriate action, as well as display appropriate dispositions to guide their behaviors. In other words, they need to be environmentally literate.

While there are many definitions of environmental literacy, EPI draws upon United Nations Educational, Scientific and Cultural Organization's (UNESCO 1978) original concept and the North American Association of Environmental Education's (NAAEE 2011) revision to define an environmentally literate person as ***someone who demonstrates the knowledge, dispositions, competencies and behaviors to actively engage, individually or as a group, in addressing environmental challenges.***

FIGURE 1.
EPI'S ENVIRONMENTAL LITERACY WHEEL

Figure 1. Offers a visual representation of EPI's definition of Environmental Literacy and the sub-dimensions within the main variables of Knowledge, Dispositions, Competencies, and Behaviors.

PROGRAM ASSESSMENT

The objective of the new EPI assessment tools is to evaluate how the environmental literacy levels of participants compare from the baseline pre-assessment to the post-assessment[1].

Research Design

In 2013 EPI redesigned its tools for program evaluation to align closely with NAAEE's proposed framework for assessing environmental literacy (NAAEE 2011). EPI's elaboration of measurement instruments and analysis of data is informed by a variety of sources including the National Environmental Literacy Assessment (NELA 2011) phase II.

The Costa Rica program was selected to pilot the tools because it involves the greatest number of local participants in its field programs, and presently is piloting new EPI curriculum that infuses lessons with more in-depth inquiry-based learning.

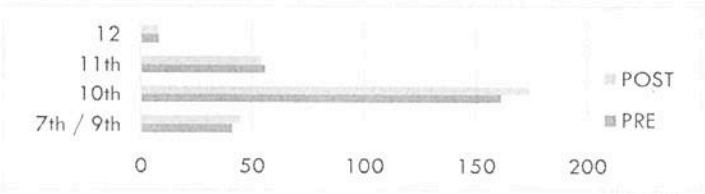
We recruited and selected a purposeful sample of 18 schools; 281students participated in the evaluation process out of a possible total of 341 (+82% participation).

Over a period of several weeks and prior to the start of individual field programs, pre-assessments were administered at schools by trained instructors and teachers to develop a baseline for 4 variables, and then delivered to EPI for data entry and analysis. Post-assessments were administered 4 days after the field experience, targeting 3 of the 4 baseline variables (Knowledge, Competencies, and Dispositions). On Sept 28th 2013, 5 months after the first school assessment, a comprehensive post- post-assessment was administered at our large end-of-season event to measure changes in the 4th variable of Behaviors.

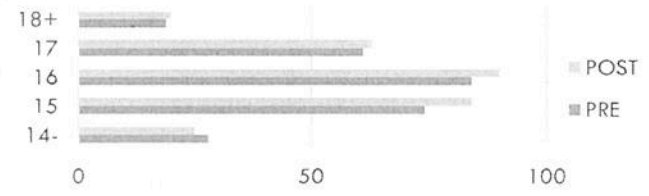
Demographics

Of the 281 participants selected for the survey, 266 completed the pre-assessment. This lower number was due to student absences at school for medical, academic, or personal reasons. Based on our sample size, the discrepant numbers did not prove significant.

Most EPI participants are 10th grade students (PRE 61% - #161, POST 62% - #174) with no significant differences in the number of study participants between pre- and post-assessments.



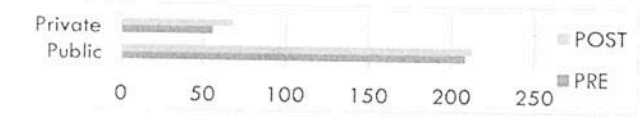
GRAPH. 1
NUMBER OF PARTICIPANTS BY GRADE LEVEL PRE & POST



GRAPH. 2
NUMBER OF PARTICIPANTS BY AGE PRE & POST

Most study participants reported their age to be between 15 and 17 years old (PRE 82% - #219, POST 84% - #237).

[1] Post post-assessment measuring "Behaviors."



GRAPH. 3
NUMBER OF PARTICIPANTS BY SCHOOL TYPE PRE & POST

GRAPH. 4
NUMBER OF PARTICIPANTS BY GENDER PRE & POST

EPI focuses its efforts in public schools near our conservation partners' sites. This focus was clearly demonstrated by participant responses, as more than three-quarters attended public institutions (PRE 78% - #208, POST 76% - #212). Furthermore, female participants made up the majority of the study group (PRE 55% - 145, POST 54% - 149).

Instruments

The new assessment tools are comprised of three instruments (Pre, Post, and Post-Post). All instruments collect demographic data that we can sort and compare, e.g., to identify rural versus urban participants. The pre- and post- instruments included school identification data to allow EPI to create school-specific reports and comparisons; the post-post assessment did not include this information. No specific data about individual participants was requested nor entered; although we did assign a unique identification number to each form to ensure data accuracy between the database and paper forms.

Based on the NAAEE evaluation framework, we created an environmental literacy index to design instruments for each variable. Each sub-dimension within the definition was assigned a weight and a maximum possible number of points, based on the importance of each from EPI's perspective. See Figure 2 for summary.

The items for these instruments were developed by EPI staff in collaboration with external advisors, and reference many additional resources including Middle School Environmental Literacy Survey (MSELS), Secondary School Environmental Literacy Instrument, Science Process Skills Inventory (SPSI) and the Children's Environmental Attitudes and Knowledge Scale (CHEAKS), among others. No individual items were copied outright.

We have utilized multiple response types: the items related to ecological and environmental Knowledge (sections "Physical and Ecological Knowledge" and "Environmental Issues") employ multiple-choice responses, while items related to "Citizen Action Strategies" (Knowledge), Dispositions, and Competencies follow a Lykert-type scale as a response format. Finally, the sections relating to Behaviors use frequency-based scale

	Item number(s)	Max Possible Points
Ecological Knowledge		**20**
Physical & Ecological Systems	5,7,8,9	6
Environmental Issues	6,10	10
Action Strategies	11-15	4
Dispositions		**25**
Environmental Sensitivity	16, 22	2.5
Attitudes/Concerns	17, 19	2.5
Personal Responsibility	23, 24	7.5
Locus of Control	18, 20	7.5
Motivation/Intention to act	21, 25, 26	5
Competencies		**25**
Identify and Ask	28	5
Design and Recolect	29	2.5
Analyzes and Interprets	30	2.5
Constructs Explanations	31	5
Articulates and presents	32,34	5
Engages in arguments	33	5
Behaviours		**30**
Ecomanagement	36-41	6
Consumer	42,43,44,46	9
Persuassion	47-49	9
Political	45	3
Legal	50	3

TABLE 1.
INSTRUMENT DETAIL

The reliability of the instruments was tested by a test-retest process with no significant variations; we assembled a panel of three experts to verify the validity of the content of the instruments.

Data Entry, Editing and Analysis

Pre- and post-assessments were collected by instructors and delivered to EPI; one instructor managed the data entry for all groups. We used separate answer sheets in order to speed up the data entry process and facilitate data verification; all data was entered manually into a database in Microsoft Excel.

The database includes separate worksheets for pre- and post-assessment raw data (RAW-PRE and RAW-POST), answer keys for both surveys (PRE-SCORES and POST-SCORES), descriptive statistics results for both tests (RESULTS-PRE and RESULTS-POST) and a summary sheet with inferential statistics results (effect size and Z-scores).

The database was monitored for data accuracy and consistency. When reviewers encountered multiple responses to a single-response item they converted the response to a blank, later leveraging imputation to replace the missing values. The database automatically used random hot deck imputation (RHD) to deal with blank answers from participants.

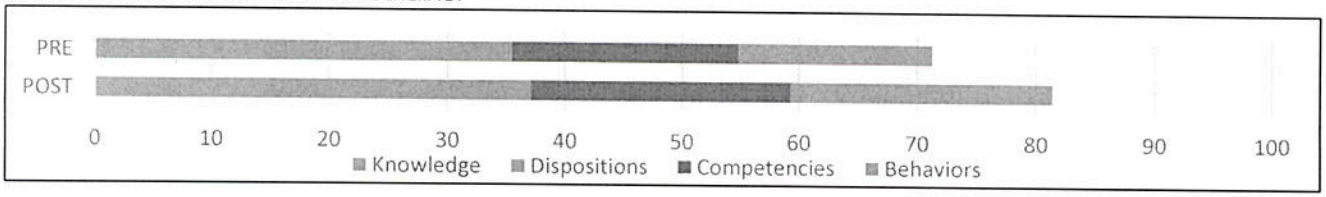
The database assigned participants' letter responses (A, B, C, D, E) numerical values for use in calculations.

Descriptive statistics were generated for each specific question (mean and standard deviation) that later were used to generate mean scores for each of the 4 variables of environmental literacy. The descriptive results from the post-assessment were compared to the descriptive results from the baseline pre-assessment using inferential statistical analysis.

To avoid confusing statistical significance with practical or educational significance, Cohen's *d* (Cohen 1998) was used to make these comparisons. In each Cohen's *d* test, the mean of the pre-test group was subtracted from the mean of the post-test group, and then divided by the pooled standard deviation. The results of Cohen's *d* are commonly referred to as effect size. Cohen indicated that $d = 0.2$ was considered a small effect size, $d = 0.5$ was a medium effect size, and $d = 0.8$ was a large effect size.

EVALUATION RESULTS

GRAPH. 5 MEAN SCORE COMPARISON
COMPOSITE SCORE FOR ENVIRONMENTAL LITERACY

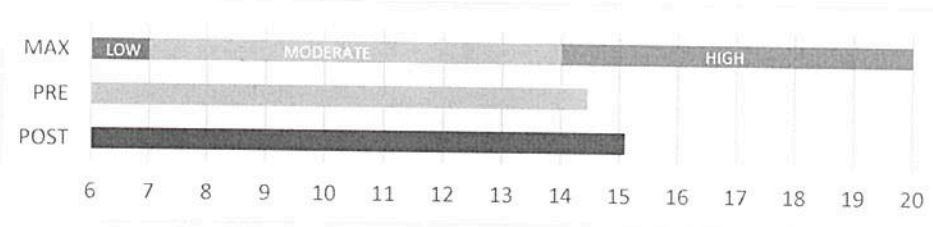


Considering Graph 5, an initial comparison of the composite scores for Environmental Literacy between the pre and post assessments indicates that there was an increase from 71.29 points to 81.41 out of a total of 100 points possible for the composite scores. This increase represents a 14.2% gain in Environmental Literacy index for the total cohort.

However, to better answer the evaluation questions, additional data and analysis is presented for each specific variable within EPI's Environmental Literacy definition.

Ecological Knowledge

GRAPH. 6 MEAN SCORE COMPARISON & MAXIMUM POSSIBLE POINTS
KNOWLEDGE COMPONENT



Cohen's *d*:
0.20
SMALL EFFECT SIZE

In graph 6, when mean score is compared between pre- and post-assessments, there is a slight increase for the composite knowledge component (from 14.45 to 15.10) and this increase yielded a small effect size (d=0.20) when pre- and post-results were tested with cohen's *d*.

TABLE 2. MEAN, STANDARD DEVIATION, COHEN'S D AND Z-TEST BY SUB-DIMENSION

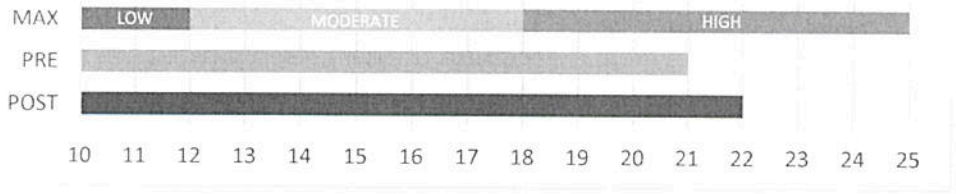
	PRE			POST					
	N	Mean	SD	N	Mean	SD	Effect Size	Z-score	
Ecological Knowledge	**263**	**14.45**	**3.21**	**278**	**15.10**	**3.68**	**0.20**	**2.18**	**SMALL EFFECT**
Physical & Ecological Systems		3.42	2.54		3.78	2.53	0.14		
Environmental Issues		8.65	3.43		8.40	3.63	(0.07)		
Action Strategies		2.39	0.79		2.91	0.76	0.66		**MEDIUM EFFECT**

Table 2 shows the means, standard deviations for pre- and post-assessments and the effect size for each of the sub dimensions of the ecological knowledge variable. A positive but small effect size (0.14) is observed for changes in EPI participants' knowledge of "physical and ecological systems." However when observing the "environmental issues" sub-dimension, a slight decrease (although not significant) in the mean score (from 8.65 to 8.40) is identified. This would imply that participants are not gaining this specific knowledge dimension from our program and that we need to pay more attention to improve curriculum for this component.

A significant increase from 2.39 to 2.91 (a gain of 22%) and a medium effect size (d=0.66) for "action strategies" shown in Table 2 is particularly of interest to EPI since its mission is to equip participants with the tools and knowledge to be able to actively participate in conservation.

Dispositions

GRAPH. 7 MEAN SCORE COMPARISON & MAXIMUM POSSIBLE POINTS
DISPOSITIONS COMPONENT



Cohen's *d*:
0.34
SMALL EFFECT SIZE

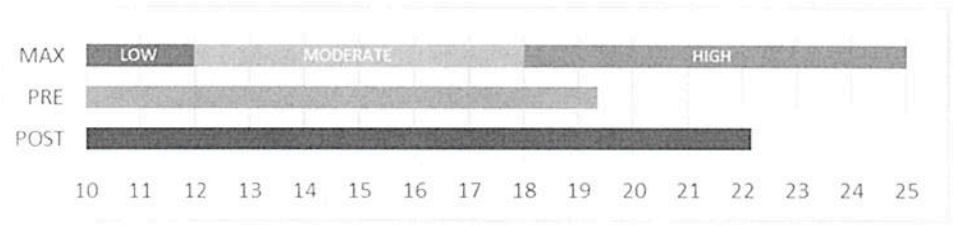
As seen in Graph 7, participants' mean score also presented a slight increase in the composite score for dispositions. However, according to Cohen's *d* test this yield indicates a small effect size. Pre-assessment scores suggest that since participants already had high disposition levels (mean higher than 18 points) before entering the program, significant changes in this component are not probable.

TABLE 3. MEAN, STANDARD DEVIATION, COHEN'S D AND Z-TEST BY SUB-DIMENSION

	PRE			POST				
	N	Mean	SD	N	Mean	SD	Effect Size	Z-score	
Dispositions	**260**	**21.00**	**2.94**	**271**	**22.00**	**2.65**	**0.34**	**4.13**	**SMALL EFFECT**
Environmental Sensitivity		2.19	0.45		2.27	0.41	0.16		
Attitudes/Concerns		2.18	0.49		2.24	0.44	0.11		
Personal Responsibility		6.20	1.59		6.53	1.36	0.20		**SMALL EFFECT**
Locus of Control		6.18	1.35		6.58	1.18	0.30		**SMALL EFFECT**
Motivation/Intention to act		4.24	0.94		4.39	0.92	0.16		

Competencies

GRAPH. 8 MEAN SCORE COMPARISON & MAXIMUM POSSIBLE POINTS
COMPETENCIES COMPONENT



Cohen's *d*:

0.84

HIGH EFFECT SIZE

A significant increase was identified comparing pre-post results for the competencies component. Cohen's *d* test also indicated a high effect size for the composite score, but most significantly it showed high effect size for those competencies specifically related to actual research work (designing, recollecting and interpreting data) and medium size effects for the other sub-dimensions.

Competencies results are particularly interesting for two reasons:

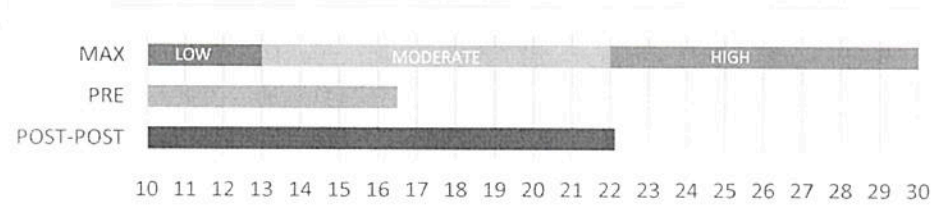
1. According to NAAEE, "[r]elatively few environmental education programs have contributed significantly to the development, application, and transfer of cognitive skills" (NAAEE 2011), but our data suggests otherwise about EPI Costa Rica as an environmental education program relative to cognitive skills.
2. The EPI Competencies component is aligned with the 21st Century Skills framework from ATC21 (ATC21 2012) and the U.S. Next Science Standards specifically within the dimension of "scientific and engineering practices" (NRC 2012).

TABLE 4. MEAN, STANDARD DEVIATION, COHEN'S D AND Z-TEST BY SUB-DIMENSION

	PRE			POST				
	N	Mean	SD	N	Mean	SD	Effect Size	Z-score	
Competencies	**262**	**19.34**	**3.37**	**281**	**22.18**	**2.97**	**0.84**	**10.40**	**HIGH EFFECT**
Identify and Ask		3.95	0.89		4.45	0.72	0.55		**MEDIUM EFFECT**
Design and Collect		1.86	0.43		2.21	0.35	0.81		**HIGH EFFECT**
Analyze and Interpret		1.90	0.44		2.27	0.34	0.84		**HIGH EFFECT**
Construct Explanations		3.83	0.90		4.50	0.68	0.74		**MEDIUM EFFECT**
Articulate and present		3.85	0.97		4.34	0.82	0.50		**MEDIUM EFFECT**
Engage in arguments		3.94	0.88		4.41	0.77	0.54		**MEDIUM EFFECT**

Behaviors

GRAPH. 9 MEAN SCORE COMPARISON & MAXIMUM POSSIBLE POINTS
BEHAVIORS COMPONENT



Cohen's *d*:

1.54

HIGH EFFECT SIZE

The behaviors component was not evaluated as part of the post-assessment due to the fact that it was not expected, nor probable to see changes in behavior immediately upon conclusion of the field program. A second post assessment (follow up) was built and completed by 157 participants during EPI's end-of-season event, which occurred at a time when resulting behavioral change could be measured. The follow up assessment had a confidence level of 95% and a confidence interval of 0.058.

TABLE 5. MEAN, STANDARD DEVIATION, COHEN'S D AND Z-TEST BY SUB-DIMENSION

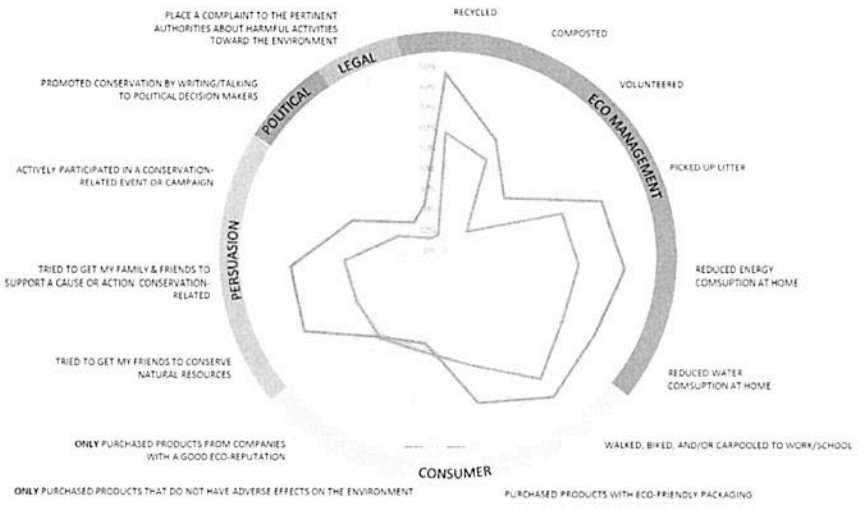
	PRE			POST					
	N	Mean	SD	N	Mean	SD	Effect Size	Z-score	
Behaviours	**255**	**16.50**	**3.66**	**157.00**	**22.13**	**3.58**	1.54	15.37	HIGH EFFECT
f Ecomanagement		3.94	1.73		4.82	1.30	0.51		MEDIUM EFFECT
f Consumer		5.27	2.34		7.43	2.12	0.92		HIGH EFFECT
f Persuassion		5.47	2.55		7.15	2.02	0.66		MEDIUM EFFECT
f Political		0.88	0.66		1.27	0.85	0.58		MEDIUM EFFECT
f Legal		0.94	0.66		1.46	0.86	0.80		HIGH EFFECT

When mean scores were compared, a very significant increase was identified and the results of Cohen's *d* comparisons also resulted in the highest effect size observed in our surveys (*d*: 1.54). This is almost double the 0.80 needed to be considered a high effect size.

The highest effect size (*d*: 92) was for the sub-dimension of "Consumer Economic Behavior," which relates to consumer action with potential for a direct impact (such as in the act of buying or selling, as well as not doing so), or an indirect impact (as in choosing to ride a bike rather than drive a car).

A more granular visualization of changes in behaviors is showed in Graph 10 which shows the percentage of participants who are "active" for each particular activity and behavior type in the last four months.

ENVIRONMENTAL BEHAVIORS
Percentage of participants active for each activity comparison Pre/Post grouped by behavior type



GRAPH.10

Active: Has done it at least once in the past two months. / Post data collected approximately six months after first intervention

It is also worth noting that while participants entered the program with high levels of Dispositions towards environmental awareness, the pre-assessment results showed that they expressed a low to moderate level of environmentally-friendly Behaviors.

These results are particularly interesting for EPI because of our mission to empower youth to take an active role in conservation (i.e., expressing described Behaviors).

IMPLICATIONS AND FUTURE STUDIES

Survey results demonstrated that EPI participants achieve significantly higher levels of environmental literacy specific to the variables of competencies and behaviors. For the variables of ecological knowledge and dispositions, however, the results showed small to medium effect sizes and just slight increases in mean scores.

These results imply that EPI's Costa Rica program has a positive overall effect on improving environmental literacy on high school level students with a strong positive emphasis on science or inquiry-related competencies and environmentally-positive behaviors.

More in-depth analyses of these and other data are needed in order to clarify whether our assessments captured students coming into the program with already-high levels in various areas, for example, as well as to address whether changes in our curriculum are needed to achieve greater results in others.

Based on the results and lessons learned from the implementation of these tools, additional assessments to measure environmental literacy will be developed for all EPI programs in Belize, México, Ecuador, Panama, and the United States. EPI is conducting a curriculum review and update (mainly of lessons about environmental and ecological Knowledge), and the latest developments will be piloted in Costa Rica in 2014, along with another round of assessments and evaluations.

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